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A STUDY OF HYBRIDS BETWEEN NICOTIANA BIGELOVII AND N. QUADRIVALVIS¹

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(WITH FOUR FIGURES)

The genus *Nicotiana* was divided by G. DON into four sections: TABACUM, RUSTICA, PETUNIODES, and POLIDICLIA. This classification has been followed in all *Nicotiana* monographs down to the present day, although several species have been shifted back and forth. The section POLIDICLIA is based upon *Nicotiana quadrivalvis* Pursh (Lehm. *Gen. Nic. Hist. pl.* 4) and its variety *multivalvis* Gray (*Syn. Fl. N. Amer.* 2¹: p. 253). (See COMES' *Monographie du genre Nicotiana*. Naples. 1899, p. 54.) The experiments on *N. Bigelovii* Watson and *N. quadrivalvis* Pursh reported in this paper show that such a section is unwarranted.

The writer began an extended series of genetic investigations upon the species of the genus *Nicotiana* in 1907 at the Connecticut Agricultural Experiment Station. Seed of several species was very generously given by Professor O. COMES of Naples, Italy, through Dr. D. G. FAIRCHILD of the United States Department of Agriculture; by Dr. A. SPLENDORE of Scafati, Italy; and by Professor W. A. SETCHELL² of the University of California. The source of the seed from Italy is unknown to me, but several of the species obtained from Professor SETCHELL were only one or two generations removed from the wild. The following description of *N. quadrivalvis* Pursh is taken from Gray's *Synoptical flora of North America*.

N. QUADRIVALVIS Pursh. A foot high, rather stout, more or less viscid pubescent, low-branching: leaves oblong or the uppermost lanceolate and the lower ovate-lanceolate, acute at both ends, mostly sessile (3-5 in. long); the

¹ Contribution from the Laboratory of Genetics, Bussey Institution of Harvard University. No. 14.

² I had the pleasure of describing some of my experiments with *Nicotiana* hybrids to Professor SETCHELL, during his visit to Boston last winter. He said at that time that he had reached conclusions similar to mine in regard to *N. Bigelovii* and *N. quadrivalvis*, although what experiments he has made I am unable to state.

lowest larger and petioled: flowers few; calyx teeth much shorter than the tube, about equalling the 4-celled (or sometimes 3-celled?) capsule: tube of the corolla barely an inch long, the 5-lobed limb an inch and a half or more in diameter; its lobes ovate and obtusish, veiny.

Oregon, and cultivated by the Indians from Oregon to Missouri; their most prized tobacco plant. Perhaps a derivative of the preceding species.³

Three sets of seed, purporting to be this species, two from Italy and one from California, were grown. The plants obtained were



FIG. 1.—At left, *Nicotiana quadrivalvis* Pursh; at right, *N. Bigelovii* Watson; young plants.

alike in every detail within the limits of fluctuating variation. One selection has bred true for four generations. They differed from the above description in only one character. The lower leaves could hardly be called petioled, although they tapered almost to a petiole. The plants when grown in a normal fertile soil always had a large number of capsules with four cells. There were individual capsules, however, with three and sometimes even two cells on the same plants. This feature is evidently a physiological variation, for when grown in small pots in the greenhouse

³ This statement, overlooked by me until the conclusion of the experiments, refers to *N. Bigelovii*.

and partially starved, the percentage of two-celled and three-celled capsules is much increased. The progeny of the starved plants gave only normal plants.

GRAY'S description of *N. Bigelovii* Watson is as follows:

N. BIGELOVII Watson. A foot or two high: leaves oblong-lanceolate, sessile or nearly so; the lower (5-7 in. long) with tapering base; the upper (3 to 4½ in. long) more acuminate, with either acute or some with broader and partly clasping base; inflorescence loosely racemiform, with all the upper flowers bractless: calyx teeth unequal, linear-subulate, about equalling the tube, surpassing the capsule: tube of the corolla 1¼ to 2 in. long, narrow, with a gradually expanded throat; the 5-angulate-lobed limb 12-18 lines in diameter.



FIG. 2.—At left, *Nicotiana quadrivalvis* Pursh; at right, *N. Bigelovii* var. *quadrivalvis*; mature plants.

Seed from Italy and from California gave plants agreeing perfectly with this description. What was not so noticeable in the published descriptions of the two species was the remarkable similarity of living plants of the two species *N. Bigelovii* and *N. quadrivalvis*. The latter differs from the former only in its smaller size and the number of cells in the capsule. Even the viscid odor, which is stronger than in other species of the genus with which I am familiar, is the same in both. It naturally occurred to me that they might both be the same species, a thought simply a little more radical than the one that had already occurred to GRAY.

The species were crossed, therefore, and gave perfectly fertile hybrids intermediate in character, with partial dominance of the

four-celled capsule. Unfortunately the cross between the normal two-celled *N. Bigelovii* and *N. quadrivalvis* has been lost. It is interesting from the standpoint of the transmission of that character, and will be remade.

The similarity of the two plants and the fact that they give a cross that is fertile in the F_1 generation is sufficient evidence to convince me that *N. quadrivalvis* Pursh is really *N. Bigelovii* var. *quadrivalvis*. There is further evidence in the fact that *N. Bigelovii* has produced a *quadrivalvis* variety while under observation.



FIG. 3.—At left, *Nicotiana Bigelovii* var. *quadrivalvis*; at right, *N. quadrivalvis* Pursh; in center, F_1 generation of reciprocal crosses.

Several plants from the different selections of *N. Bigelovii* with a single capsule having three cells were observed. Seeds from these plants were selected with the object of producing a race having three-celled capsules. Selection had absolutely no effect. Among the progeny an occasional three-celled capsule was found, but the percentage could not be increased. In this strain of *N. Bigelovii* there was evidently no ability to transmit the three-celled character. It simply gave an occasional zygotic variation of this kind, just as do many other species of *Nicotiana*.

On the other hand, several other plants, typically *N. Bigelovii* in size, produced several three-celled capsules. It is quite probable that they were all progeny of one plant of the preceding generation. One of these plants was selfed and the resulting seed planted on

rich ground the following year.⁴ Each plant among the progeny had numerous three-celled capsules, together with occasional two-celled and four-celled capsules. For two generations the strain has bred true to this condition. The only other abnormality observed is the occurrence of a greater number of flowers with six sepals and six petals than is common in the normal *N. Bigelovii* or the *N. quadrivalvis*. About 1 per cent of the flowers from the normal species have the extra petal and sepal, but on individual plants in



FIG. 4.—At left, *Nicotiana Bigelovii* var. *quadrivalvis*; at right, *N. quadrivalvis* Pursh; in center, F_1 generation of cross.

the aberrant strain of *N. Bigelovii* from 2 to 5 per cent of the flowers vary in this manner.

The aberrant *N. Bigelovii* was crossed reciprocally with *N. quadrivalvis*. The F_1 plants were alike in each case. They were intermediate in stature and in size of flower. The earlier capsules were four-celled; later in the season both three cells and two cells were produced. The F_1 plants were fully as fertile as the parent species. Each plant produced hundreds of well filled capsules.

⁴ Seeds are always started in sterilized soil and seedlings set in the open.

One plant each from the cross and its reciprocal were selfed. About 70 plants were grown from each mother plant. No difference was noticed in the two F_2 generations. The entire lot can therefore be considered together. The plants varied in height from one foot to two feet. The flowers were in general intermediate in size, but varied to the extremes that characterize each parent. No plants having only two-celled capsules were found; 71 had a large number of four-celled capsules; 40 had only a few four-celled capsules; while 19 had no four-celled capsules. Every plant had large numbers of three-celled and two-celled capsules, whether or not four-celled capsules were present.

Summary

1. Two elementary species of *N. Bigelovii* Pursh have been found. In one the capsules are two-celled and selection of individuals having an occasional three-celled capsule does not increase the tendency; in the other the tendency to have a greater number of cells than two in the capsule is always transmitted.

2. *N. quadrivalvis* Pursh and normal *N. Bigelovii* Watson are alike in all specific characters except the number of cells in the capsule, and since they give fertile hybrids when crossed it is thought that *N. Bigelovii* gave rise to *N. quadrivalvis*.

3. It is proposed that the section *POLIDICLIA* in the genus *Nicotiana* be dropped, and *N. quadrivalvis* Pursh be called *N. Bigelovii* var. *quadrivalvis*.

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